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Determination of the Total Level of Nitrosamines in Select Consumer Products in Lagos Area of Nigeria

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For sometime there has been a considerable interest and growing concern in the extent of contamination of food items by N-nitrosamines because of the known carcinogenicity and mutagenicity of these compounds (Bartsch et al 1980). Extensive reviews on carcinogenicity and the reaction mechanisms of organic N-nitroso compounds have been published (Magee and Barnes, 1967; Druckrey and Preussmann, 1962). Nitrosoamines have been detected in meats cured with nitrite and other foods such as fish, cheese, alcoholic beverages and in many aspects of our immediate environment (Anucha et al, 1986).

Nitrosamines can be derived from the interaction of organic secondary and tertiary amines with nitrite, nitrate under reducing conditions, low pH values or nitrous gases. The formation of dimethylnitrosamine (up to 100 ppm) has been demonstrated in nitrate treated fish meal (Sakashaug et al, 1965). Minute amounts of nitrosoamines have been detected in tobacco smoke (Serfontein and Hurter, 1966). In addition to the information available on the presence of N-nitroso compounds in foods and tobacco smoke, other chemicals of this group are used as intermediates in certain chemical and paint industries, and some of these derivatives are sold as pesticides, rubber additives and for many other applications. In Nigeria, the present harsh economic conditions have somewhat influenced the emergence of different kinds of socio-economic attitude in Nigerians. There is now high incidence of adulteration of many consumer products. Faking of assorted consumables and pharmaceuticals, notably drugs, is a common feature, all in attempt to cut corners. It is a common practice amongst the local people to use certain chemicals as preservatives, colorants and flavorants without taking cognizance of the long-term health and toxicological hazards posed to the citizenry by these foreign agents. For example the substitution of industrial salt for common cooking (edible) salt by some unscrupulous and callous Nigerians has now caught the attention of the health authorities. Recent preliminary work in our laboratory had shown the presence of N-nitrosamines in some consumer products and it was therefore thought that a more thorough investigation and survey of as many foods and drinks as possible in the Lagos

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metropolis for contamination by nitrosamines might present a more revealing picture.

MATERIALS AND METHODS

The consumer products used in this study were obtained from about 20 different locations and market places within the city of Lagos and these include meat products, fish products, alcoholic beverages, drinking water, industrial effluents, tobacco products, body creams and lotions, hair creams. All the reagents and chemicals used were products from British Drug Houses (BDH) and are analytical reagent grade.

The detection and quantification of nitrosamines were carried out by a modification of Telling and Dunnett Method (1981). About 20g of sample was weighed out (homogenised, for meat and fish products) and transferred into a 100ml conical flask. To this was added ammonium sulphamate, 0.5g, and thoroughly stirred. Sodium chloride solution, 20ml, (20%w/v) was added, stirred for about 15-20 minutes and the mixture completely transferred to a 200 ml separatory funnel. The flask was rinsed with 2 portions of 5ml sodium chloride solution and these added to the content of the separatory funnel. The combined aqueous layer was extracted with hexane, 2 x 50ml, and the hexane layer discarded. The aqueous phase was furgher extracted with ethyl acetate 3 x 50ml and the combined organic phase dried over anhydrous sodium sulphate concentrated to about 1 ml on a rotary evaporatory using a water bath at $50^{o}C$.

The residue was duplicated in two reaction tubes, each containing 0.5ml of the mixture. While one tube served as the test sample, the other served as control blank. A portion, 0.2ml, of the denitrosation reagent (3%v/v HBr in glacial acetic acid) was added to the test sample portion and the tube placed in a water bath ($50^{o}C$ for about 5 minutes. To control blank was added 0.2ml of distilled water. A 0.2ml portion of sulphanilamide solution (0.2%w/v in HCl) was added to each tube and the contents mixed by shaking intermittently for about 5 minutes. A 0.1ml portion of N-1 naphthyl reagent (0.1% w/v N-naphthyl ethylenediamine dihycrochloride) was added to each tube. After about 25 minutes the adsorbance of the test sample was measured at 540nm wavelength against the control blank. Using a sodium nitrite standard (calibration graph regression), the total level of N-nitroso compounds in the test samples measured as nitrosodiethanolamine (NDELA) was obtained by means of the expression -

$$\frac{\text{ug ml}^{-1}\text{NaNO}_2 \text{ (from calibration graph)}}{\text{mass of sample (g)}} \times \frac{1}{0.5} \times \frac{30}{69} \times \frac{100}{2.4} \text{ ug g}^{-1}$$

RESULTS AND DISCUSSION

The tobacco products analysed for nitrosamine contamination include cigarettes, tobacco leaf, finished pipe tobacco and tobacco snuff. The lowest values were obtained for tobacco leaves and cigarettes, while finished pipe tobacco and tobacco snuff gave appreciably high values giving an indication that nitrosation and nitrosamine precursors may be due to raw tobacco and additives and the mode of tobacco processing (Table 1).

Dairy products returned the lowest level of nitrosamine contamination. Powdered milk samples and baby food mixtures were found to contain little or no nitrosamine contamination, however traces of nitrosamine were detected in dairy products such as liquid milk preparations.

The examination of borehole water and industrial effluents presents interesting results of nitrosamine contamination. Borehole water was obtained from 4 different locations. Low values of nitrosamine were obtained in borehole water from outside the city, while samples obtained from within the city showed higher values more so when such boreholes are close to industries.

Table 1. Total level of N-nitroso compounds obtained in local products in Lagos area of Nigeria.

Products	Brand	N-nitroso compound as NDELA (mg/kg)	
		Range	Mean
Tobacco products	10	0.01 - 0.03	(0.02)
Dairy products	5	0.01 - 0.01	(0.01)
Borehole water	4	0.02 - 0.10	(0.05)
Industrial effluent	6	1.50 - 1.90	(.175)
Treated industrial effluent	6	0.02 - 0.05	(0.03)
Alcoholic beverage	10	0.01 - 0.02	(0.01)
Raw meat products	5	0.14 - 0.30	(0.20)
Cooked meat products	5	0.01 - 0.01	(0.01)
Smoked fish products	5	0.10 - 0.20	(0.16)
Pre-grilled meat (spiced)	10	0.90 - 1.60	(1.30)
Post-grilled meat (spiced)	10	0.80 - 0.90	(0.83)
Skin cream products	10	0.20 - 1.30	(0.80)
Body lotions	5	0.03 - 0.24	(0.14)
Hair creams	5	0.01 - 0.03	(0.02)
Guinea corn	10	0.02 - 0.28	(0.14)

Industrial effluents running into open rivers and seas showed very high levels (1.5-1.9mg/kg). Highest values of nitrosamines were found in effluents from chemicals, paint and oil-related industries. However, on treatment, the level of contamination of certain industrial effluents was found to decrease. Virtually all of the brands of alcoholic beverages (beer, stout, any spirits) examined showed the presence of nitrosamine contamination. Similar findings have been found by Basir et al (1978) who reported the occurrence of nitrate, nitrite, diethylamine, dimethylnitrosamine in some fermented beverages.

In our analysis of meat and fish products we found that roast meat and smoked fish contained very high levels of nitrosamine; raw meat (0.14-0.3) smoked fish (0.1-0.12), spiced grilled meat (locally called suya) (0.8-1.6mg/kg). It becomes obvious that the sources of nitrosamine contaminants was the coating spice thought to be made of peanut powder, pepper, vegetable oil and salt mixture. A wide range of bacterial flora in 'suya' has been reported (Igene, 1983) and the possibility of bacterial accentuated nitrosation reaction leading to high level of nitrosamine in cold meat products has been suggested (Igene and Abulu 1984). Another source of nitrosamine formation could be the preservatives for cold meat and fish products, an attitude that has become customary with our local people. Natural products like guinea corn extracts examined show the presence of nitrosamine contamination. The analysis of the different types of guinea corn extracts shows different levels of contamination (0.02-0.28mg/kg).

The present investigatory studies were extended to include some externally used preparations. We found that nitrosamine contamination of locally made body creams and lotions, and hair cream ranged from 0.01-1.24mg/kg. The probable sources of nitrosamine contents in such preparations is not too clear to us, however, work in this direction is continuing.

REFERENCES

Bartsch H, O'Neil IK, Schulte-Herman R (1986). Relevance of N-nitroso compounds to human cancer. Exposures and mechanisms. Proceedings of the IX International Symposium on N-nitroso compounds, Baden, Austria. Pp.1-10.

Basir O, Maduagwu EN (1978). Occurrence of nitrate, nitrate, diethylamine, dimethylnitrosamine in some fermented Nigerian beverages. J Agr Food Chem 26: 200-203.

Druckrey H, Preussman R (1962). Zue Entstenhung Crcinogene Nitrosamine am Beispiel des Tabakrauchs. Naturwissenschaften 49: 498-499.

Igene JO (1983). Total plate count and coliform density for retail suya. Trop. Veterinarian 1: 85-91.

Igene JO, Abulu EO (1984). Nutritional and Bacteriological characteristics of tsine-type suya, a popular Nigerian meat product. J Food Protect. 47(3): 193-196.

Magee PN, Barnes JM (1967). Carcinogenic compounds. Advances Cancer Res 16: 163-246.
Anucha TCA, Okieimen FE, Ajibola MM (1986). Contamination of meat products by trace quantities of Nitrosodiethanolamine (NDELA). Bull Environ Contam Toxicol 36: 392-395.
Sakshaug J, Dognrn E, Hansen MA, Koppnang N (1965). Dimethylnitrosamine; its hepatotoxic effect in sheep and its occurrence in toxic batches of herring meal. Nature 206: 1261-1262.
Serpontein WJ, Hurter P (1966). Nitrosamine as environmental carcinogens. Evidence for the presence of nitrosamines in tobacco smooth condensate. Cancer Res 26: 575-579.
Telling GM, Dunnett PC (1981). The determination of N-nitrosodiethanolamine (NDELA) at trace levels in shampoos and skin cream by a sample, rapid colorimetric method. Int J Cosmet Sci 3: 241.

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